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The Status of Glaucous Gulls *Larus hyperboreus* in the Circumpolar Arctic

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ABSTRACT. The entire world population of the Glaucous Gull *Larus hyperboreus* breeds in the circumpolar Arctic. Some local populations appear to be declining significantly. In this paper, we summarize the current state of knowledge on Glaucous Gull populations and trends. The total Arctic population is estimated at 138 600 to 218 600 breeding pairs (277 200 to 437 200 breeding individuals) distributed among at least 2768 colonies (many not documented). Population declines may be attributable to egg harvest, contaminants, or food shortages, but other factors operating outside the breeding season should not be excluded. We recommend collaborative conservation efforts that will include better population estimates in most countries, as well as standardized monitoring programs.

Key words: Glaucous Gull; *Larus hyperboreus*; Arctic; population status; population trends; monitoring; conservation concerns

RÉSUMÉ. Toute la population mondiale de goélands bourgmestres *Larus hyperboreus* se reproduit dans l'Arctique circumpolaire. Certaines populations locales semblent diminuer considérablement. Dans cette communication, nous résumons l'état actuel des connaissances sur les populations et les tendances concernant le goéland bourgmestre. La population arctique totale est estimé de 138 600 à 218 600 couples reproducteurs (de 277 200 à 437 200 individus reproducteurs) répartis dans au moins 2 768 colonies (dont grand nombre n'ont pas été consignées). Les déclins de population peuvent être attribuables à la récolte des œufs, aux contaminants ou aux pénuries de nourriture, bien qu'il ne faille pas exclure d'autres facteurs ne se rapportant pas à la saison de reproduction. Nous recommandons des efforts de conservation communs qui comprendront de meilleures estimations de population dans la plupart des pays de même que des programmes de surveillance normalisés.

Mots clés : goéland bourgmestre; *Larus hyperboreus*; Arctique; état de la population; tendances de la population; surveillance; préoccupations de conservation

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INTRODUCTION

The entire global population of the Glaucous Gull *Larus hyperboreus* (Fig. 1) breeds in the Arctic, with a widespread, circumpolar distribution (Burfield and van Bommel 2004; Fig. 2). Although most also winter within the Arctic region, some birds disperse south towards Japan and California in the Pacific or towards northwestern Europe and the Carolinas in the Atlantic (Cramp, 1983; Gilchrist, 2001). During the non-breeding season, birds may disperse in offshore waters, where they are often associated with sea ice or the ice edge, and in association with walrus *Odobenus rosmarus* and seals near open leads and polynyas (K.J. Kuletz, unpubl. data).

Four subspecies of the Glaucous Gull are generally recognized: *hyperboreus* in the European Arctic and western Siberia, *leuceretes* in West Greenland and most of the Canadian Arctic, *barrovianus* in Alaska and east to the Mackenzie River in Canada, and *pallidissimus* from eastern Siberia to the Pribilof Islands (Banks, 1986; Liebers et al., 2004; de Knijff et al., 2005).

Glaucous Gulls breed primarily on or near the coast, sometimes a few kilometers inland. On the Taimyr Peninsula, Russia, they can breed along riverbanks more than

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FIG. 1. Glaucous Gulls on Franz Josef Land, Russian Arctic. Photo: Maria Gavrilo, August 2007.

100 km inland (Rogacheva, 1992; Yudin and Firsova, 2002). Breeding sites may be used by a single pair or up to more than 1000 pairs (Mineev and Mineev, 2000; Gilchrist, 2001; Strøm, 2006a; Zöckler et al., 2009). Glaucous Gull nest locations are highly variable, including grassy slopes, low islands on lakes near the coast, tops of rock stacks, and ledges on steep, inaccessible cliffs, where the gulls often nest together with other seabirds (Gudmundsson, 1955; Gilchrist, 2001). Level ground is also used on the mainland where mammalian predators are uncommon, for example, in Alaska, Arctic Canada, and Franz Josef Land, Russia.

The Glaucous Gull is a species of international responsibility for the Arctic countries, some of which (United States, Canada, Greenland, Iceland, Norway, Russia) harbour the entire world breeding population. Evidence of recent declines prompted biologists in these countries to review available published and unpublished information on this species, to examine the distribution, status, and trends of breeding Glaucous Gulls in the circumpolar Arctic. They have also examined current monitoring activities to see how well changes in the different populations are documented and to evaluate the main concerns for Glaucous Gulls.

METHODS

The U.S. Fish and Wildlife Service conducts the Aerial Breeding Bird Survey, a population monitoring program that includes Glaucous Gulls, in the Yukon-Kuskokwim Delta coastal region and the Arctic Coastal Plain region. The Survey has indexed the abundance, population trend, and distribution of Glaucous Gulls since 1992. The North Pacific Pelagic Seabird Database (NPPSD, 2014) includes data since 1975 on distribution of Glaucous Gulls at sea. Seasonal and spatial aspects of survey effort, which were largely opportunistic vessel-based surveys, need to be addressed before long-term trends in at-sea distribution can be examined. Pelagic survey effort in Alaska increased in 2006 and continued through 2014.

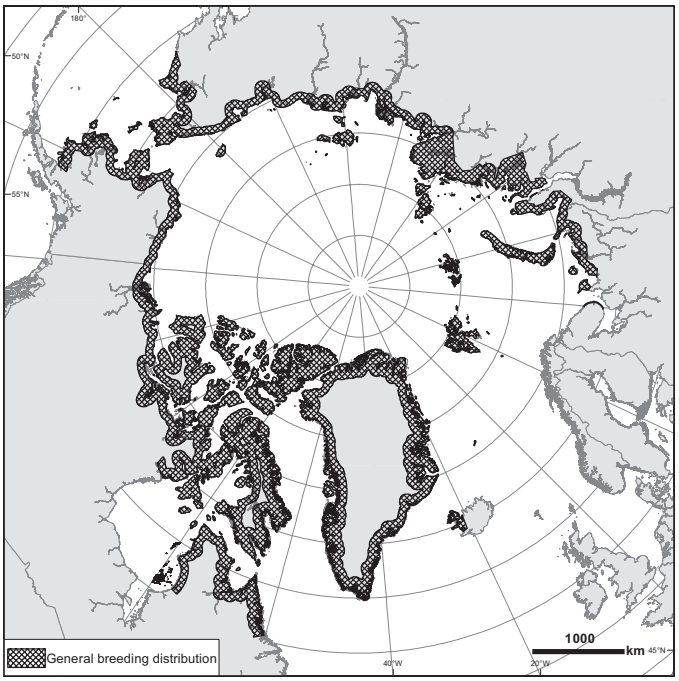

FIG. 2. The Glaucous Gull has a truly circumpolar breeding distribution.

Environment Canada has also monitored Glaucous Gull breeding populations at five locations in the Canadian Arctic. However, this monitoring is typically auxiliary to focal research on other seabirds and is generally not systematic. Although research has been conducted recently on Glaucous Gulls in the Canadian Arctic (Allard et al., 2010; Wayland et al., 2010), reproductive success is monitored only once a year on Coats Island and every 2–3 years on Prince Leopold Island (Gaston et al., 2005, 2009). Distribution of Glaucous Gulls away from the breeding colonies is also recorded during opportunistic at-sea surveys (Fifield et al., 2009; McKinnon et al., 2009).

In Greenland, no monitoring program covers Glaucous Gull colonies, and data on population trends are fragmentary and not systematic. However, Glaucous Gulls are included in programs that monitor contaminants in Greenland taxa (Cleemann et al., 2000; Riget and Dietz, 2000; Riget et al., 2000; AMAP, 2005; Vorkamp et al., 2012).

In Iceland, no organized monitoring program exists for Glaucous Gulls. Individual colonies have been surveyed for numbers at irregular intervals, but until a recent census, coverage for larger areas during the same time period was limited (Petersen et al., 2014). Winter numbers and distribution are monitored annually as part of the Icelandic Christmas Bird Counts (Petersen, 1983), but no other population parameters are monitored.

In Bjørnøya, Svalbard, the number of breeding pairs (from 1986), adult survival, and breeding success are monitored annually by the Norwegian Polar Institute. In 2012 monitoring was started in Kongsfjorden, Spitsbergen (Descamps et al., 2013). Glaucous Gulls are also included in contaminant monitoring programs for Svalbard taxa.

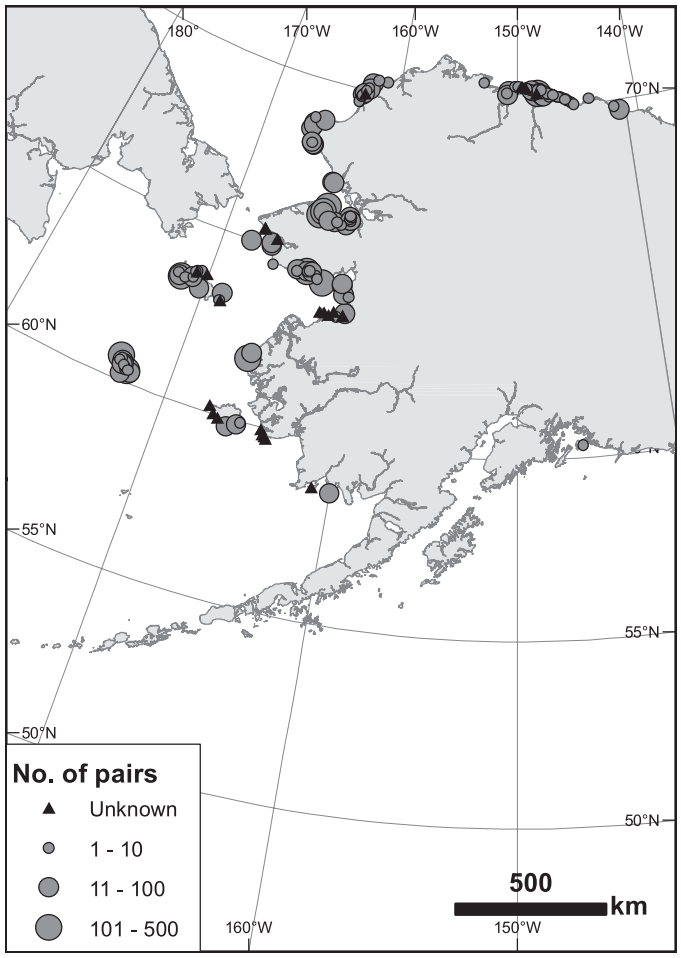

FIG. 3. Distribution of coastal Glaucous Gull colonies in Alaska. Note, however, that the gulls also breed inland.

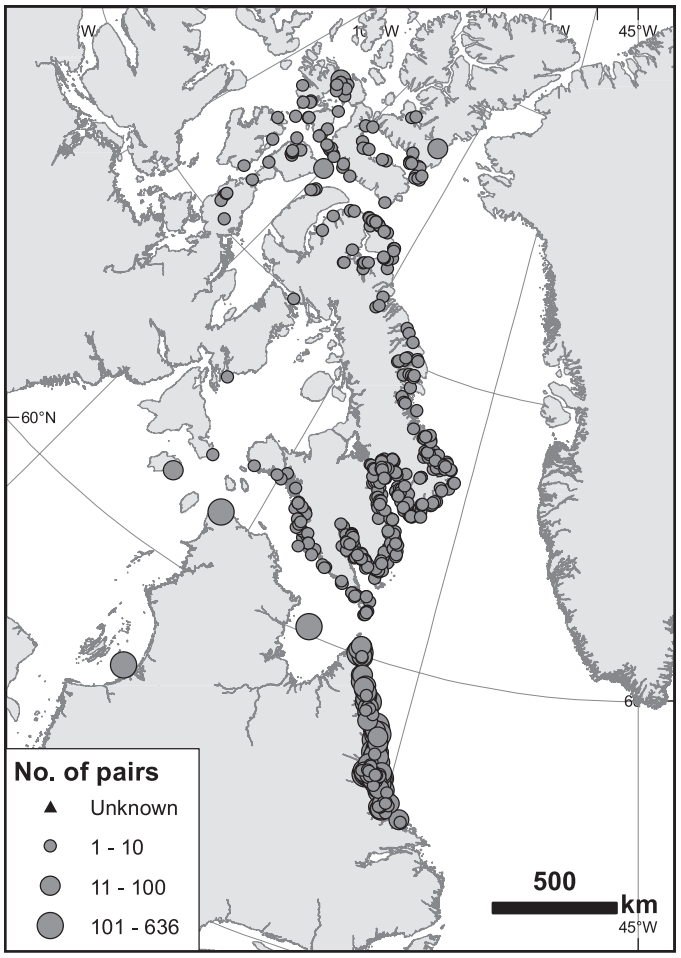

FIG. 4. Map showing Glaucous Gull nesting locations mapped along the marine shorelines in northern Labrador, Quebec, and Nunavut. Glaucous Gulls also nest in pairs or small colonies in the central and western Canadian Arctic, but those breeding locations have not been mapped.

Russia has no specific monitoring programs for Glaucous Gulls, although some repeated surveys of abundance have been undertaken in several locations as parts of general seabird surveys. The recently established Russian Arctic National Park includes Glaucous Gulls on the list of its seabird monitoring network.

RESULTS

Breeding Distribution

In the United States, the subspecies *L. h. barrovianus* occurs along the coast and inland in northern and western Alaska (Fig. 3). Moving east into Canada, the subspecies *L. h. leuceretes* occurs throughout coastal parts of Yukon, the Northwest Territories, and Nunavut, as well as in Nunavik (northern Quebec) and northern Labrador (Fig. 4). The Glaucous Gull *L. h. leuceretes* is a widespread breeder throughout Greenland (Fig. 5), occurring mainly in small colonies and solitary pairs, often within or close to colonies of other seabird species (Boertmann, 1994). In Iceland, the species currently breeds principally in the northwest (Fig. 6), in the regions of Vestfirðir, Breiðafjörður, and Faxaflói, but the breeding range contracted considerably through the 20th century from its former extent around the country (Ingólfsson, 1982; Petersen, 1998; Petersen et al., 2014). The Norwegian breeding population of Glaucous Gulls is found on the islands of Jan Mayen (*L. h. leuceretes*; Fig. 7) and Svalbard (*L. h. hyperboreus*; Fig. 8). In Russia, the breeding range is not well documented, so only the better-known sites are depicted in Fig. 9. Gulls breed along the mainland coast and throughout the Russian Arctic archipelagoes (Kokhanov, 1981; Yudin and Firsova, 2002). Two subspecies are found in the Russian Arctic: *L. h. hyperboreus*, in the western part towards East Taimyr, and *L. h. pallidissimus* east of the Lena Delta (~ 126˚ E), with an intergrade zone between these areas (Stepanyan, 2003).

Wintering Distribution in the Arctic

During winter, Glaucous Gulls are reported in the pack ice and polynyas of the Bering Sea as well as near the Aleutian and Pribilof Islands (U.S. Fish and Wildlife Service, 2009), along Newfoundland and Labrador (Brown et al., 1975; Allard et al., 2010), and in polynyas of southern

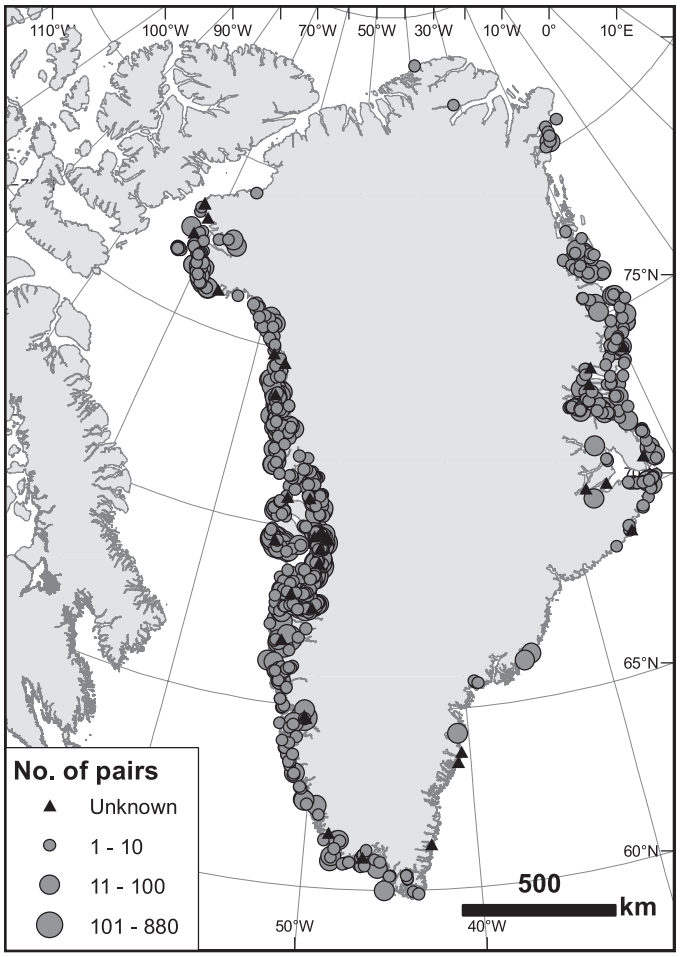

FIG. 5. Distribution of Glaucous Gull breeding sites in Greenland, as recorded in the Greenland Seabird Colony Register (n = 829). Survey effort in North and Southeast Greenland is very low, and the literature indicates that the species is more widespread in those areas than the map shows.

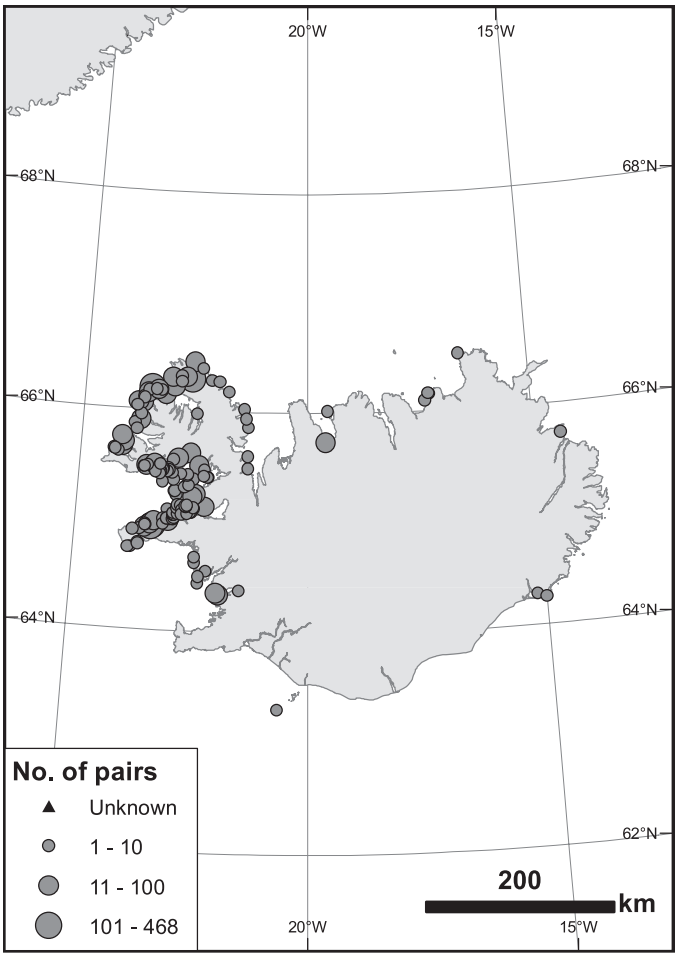

FIG. 6. Distribution and relative numbers of Glaucous Gulls nesting in Iceland. Most of the data are from 2005 to 2011, but older data have been used for areas not surveyed in those years. Birds at breeding sites away from the core regions of western and northwestern Iceland most likely included Glaucous Gull–Herring Gull hybrids.

Hudson Bay, Canada (Gilchrist and Robertson, 2000). Many birds from Canada, Svalbard, and Iceland may winter along the more or less ice-free coasts of West Greenland (Gilchrist, 2001; Lyngs, 2003; Boertmann et al., 2004). In the European Arctic, Glaucous Gulls winter along the coast and offshore in mainland Norway, the Faroes, and Iceland, and in the ice-free parts of the Barents and Greenland Seas (Petersen, 1998; Bakken et al., 2003; Strøm, 2006a).

Population Estimates

Population estimates for Glaucous Gulls are difficult because of the large extent and remote nature of the breeding range, and their numbers are poorly known, except for Iceland. The most up-to-date information suggests that there are more than 2768 colonies in the circumpolar Arctic, supporting between 138 600 and 218 600 breeding pairs of gulls (Table 1). Many seabirds skip breeding in some years (Hamer et al., 2002), so the total breeding population could be more than 437 200 breeding individuals, and there are also many immature birds and other non-breeders.

Approximately 100 000 individuals have been reported for Alaska (U.S. Fish and Wildlife Service, 2009), but only 158 colonies have been documented (Seabird Information Network, 2012). Of these, 132 colonies have population estimates that total about 8000 individuals, and only 36 of these colonies have been surveyed since 1992.

Gilchrist (2001) estimated 69 000 individuals distributed in at least 1000 colonies in Canada, but this estimate was based on coarse data from the 1970s and probably included some Iceland Gulls *Larus glaucoides*. Gaston et al. (2012) revised this estimate downward to 25 000 individuals, acknowledging that this number is likely a minimum estimate.

The Greenland Seabird Colony Register includes 830 colonies or breeding sites, totaling approximately 12 000 pairs. However, like the Canadian figure, this is an underestimate, as many solitary breeding pairs and colonies smaller than five pairs are not included. Thus, the population estimate of 20 000–100 000 pairs given by Boertmann et al. (1996) is still the best available for Greenland.

In Iceland, the breeding population was estimated at 3500 pairs in 1955 (Gudmundsson, 1955), and two decades later it was thought that the Breiðafjörður region alone

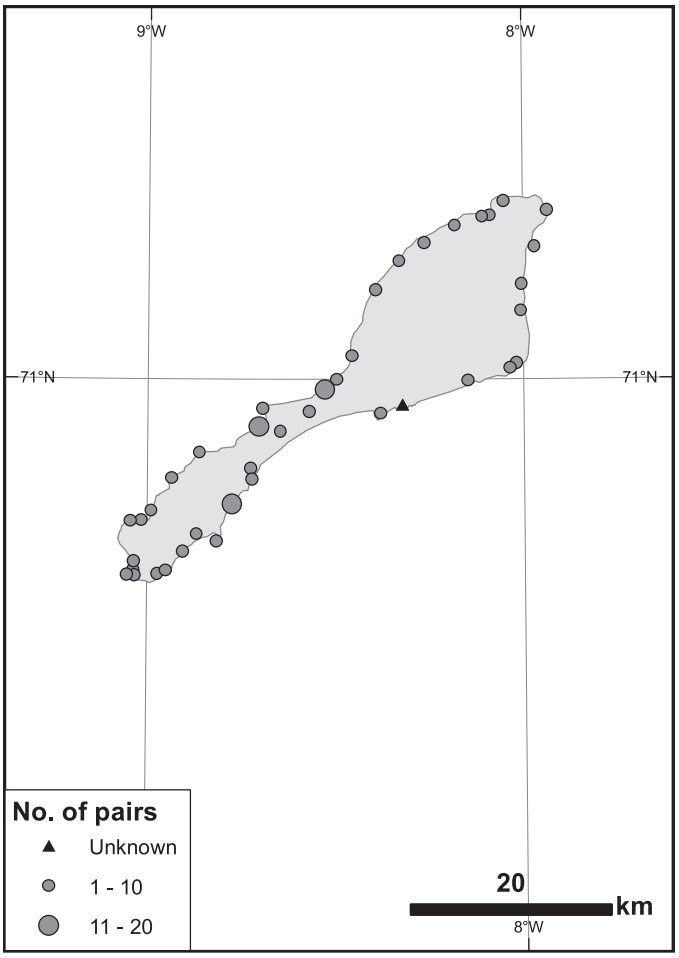

FIG. 7. Distribution of colonies/breeding sites and relative numbers of Glaucous Gulls on Jan Mayen, based on censuses conducted in 2010. Data from the Seabird Colony Registry of the Barents and White Seas (Norwegian Polar Institute/SEAPOP).

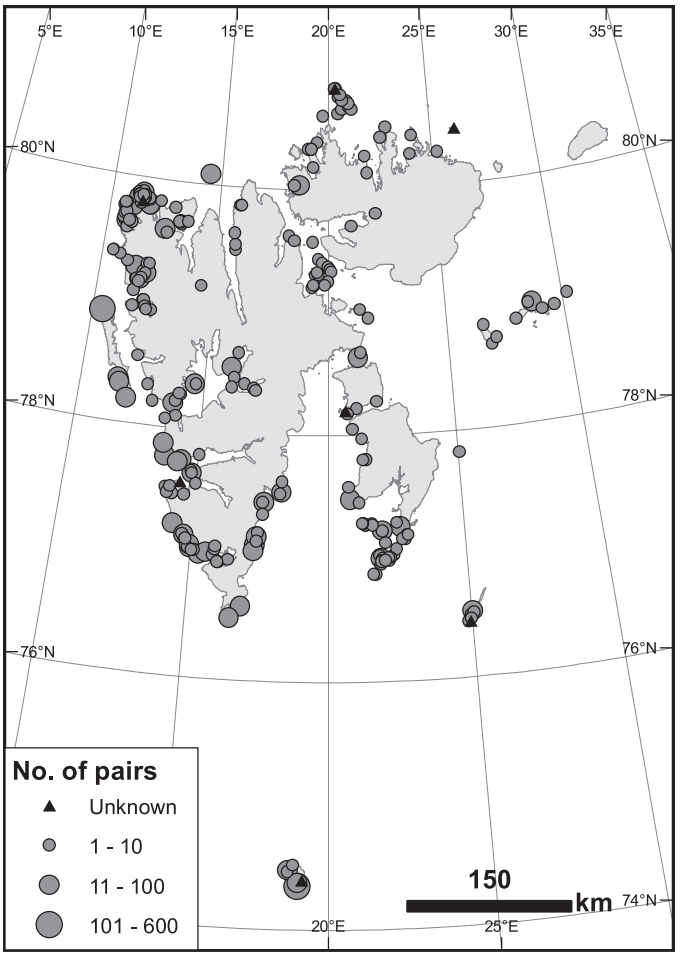

FIG. 8. Distribution of colonies/breeding sites and relative numbers of Glaucous Gulls in Svalbard, based on censuses conducted from 2006 to 2012. Data from the Seabird Colony Registry of the Barents and White Seas (Norwegian Polar Institute/SEAPOP).

supported 3500 breeding pairs (Gardarsson, 1973). The population estimate later increased to 10 000 pairs (Ingólfsson 1982), but by 1995 it was reassessed downwards to 8000 breeding pairs (Asbirk et al., 1997; Petersen, 1998), with the largest colony supporting 1400 pairs. In 2005–09, a new census of Glaucous Gulls in the principal breeding areas in Iceland suggested only 2400 breeding pairs, distributed among 245 breeding locations, which includes sites of single pairs and some of possible hybrid pairs with Herring Gull *Larus argentatus* (Petersen et al., 2014).

In Svalbard, a total 230 colonies are known (SCRIB, 2009), most of which are on the west coast of Spitsbergen and Bjørnøya. Estimates based on the 1980s and 1990s censuses in Svalbard suggest a total breeding population of up to 10 000 pairs (Mehlum and Bakken, 1994; Strøm, 2006a), but new surveys in 2005–12 indicated a population size close to 4000 pairs (Strøm, 2006b; H. Strøm and S. Descamps, unpubl. data). On Jan Mayen, a census in 2010 documented a minimum of 181 breeding pairs in 40 colonies (H. Strøm, unpubl. data).

Only a rough population estimate of approximately 50 000 breeding pairs can be provided for the entire Russian Arctic, with more than 20 000 *hyperboreus* and 30 000 or fewer *pallidissimus*. No overall historical estimates are available, nor have broad-scale surveys been conducted in the western part of the species' range. Most regional population estimates must be considered crude at present (summarized in Table 2). On the basis of data from 1936 to 1994, Bakken and Tertitski (2000) estimated that on Novaya Zemlya, there are at least 55 colonies with at least 1000 breeding pairs, which is undoubtedly an underestimate since many areas were not surveyed. An estimate based on data collected before the 1990s gave more than 100 colonies with ~500 pairs on Franz Josef Land (Bakken and Tertitski, 2000). A recent estimate gave more than 70 colonies with probably 2000–3000 pairs (M. Gavrilo, unpubl. data). The previous estimate for the southeastern Barents Sea was at least 1500 pairs (Bakken and Tertitski, 2000), but a recent update provided data for up to 1900 pairs in two locations (Mineev and Mineev, 2000; Zöckler et al., 2009). Farther east, in the Kara Sea, the limited data suggest more than 75 recorded colonies, most of them in the Severnaya Zemlya archipelago (Gavrilo and Bakken, 2000), and numbers estimated at under 1000 pairs (de Korte et al., 1995).

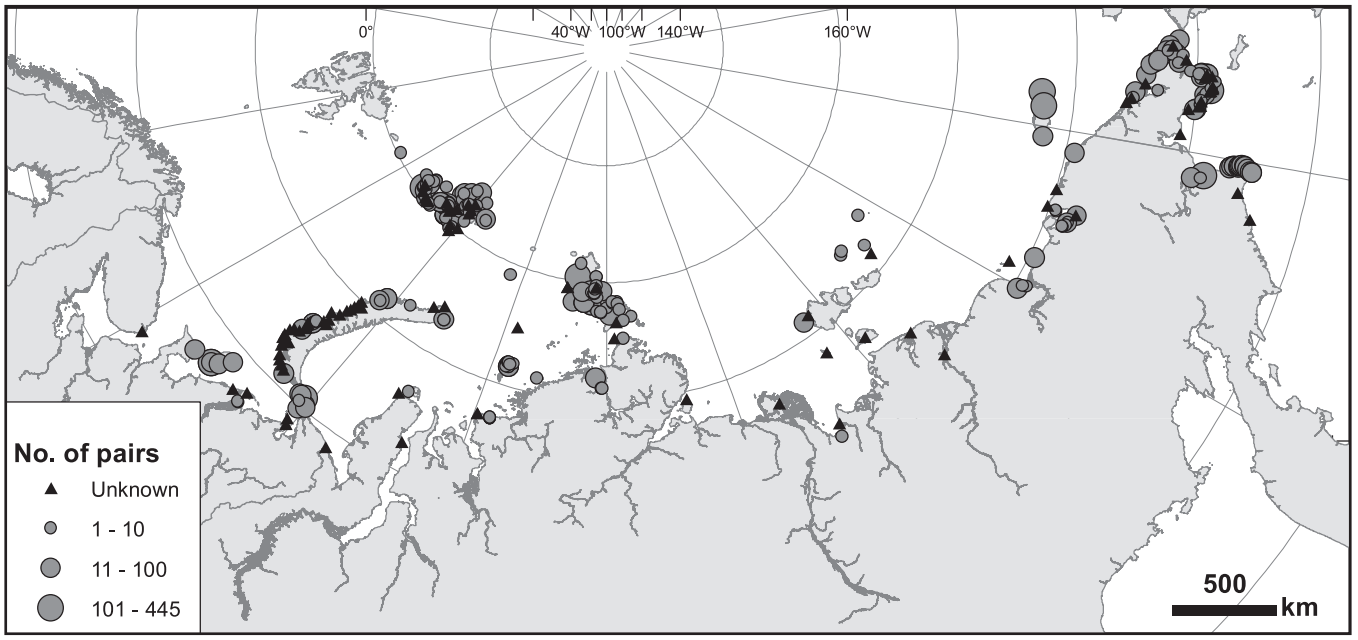

FIG. 9. Breeding colonies of Glaucous Gulls in Russia. Only the better-documented breeding sites are presented because the distribution is poorly mapped, especially on the mainland, where the gulls mostly dispersed on flat tundra or salt marshes.

Population Trends

Since 1992, aerial breeding bird surveys of the Arctic Coastal Plain (northwestern Alaska east to the Alaska–Canada border) have documented Glaucous Gull populations, providing indices between 10 000 and 20 000 birds, with a mean population index of about 13 000 that was considered stable from 1992 to 2006, but increased from 2001 to 2010 (Larned et al., 2011). Over this same time period (1992 to 2010) in western Alaska, estimates of the population have fluctuated around a mean of about 38 000 birds (annual range 21 000–67 000; Platte and Stehn, 2009).

Surveys in Canada have not been conducted systematically or annually, as in Alaska, but sporadically and often ancillary to other research. Around the Belcher Islands (56˚ N, 79.5˚ W), Gilchrist and Robertson (1999) found a 50% decline in breeding numbers from 1985 to 1997. At Digges Sound (62.5˚ N, 78˚ W) from 1980 to 2008, A.J. Gaston (unpubl. data) documented a decrease of about 50% from the initial ~55 nests at this colony. On nearby Coats Island (63˚ N, 82˚ W), one of two colonies has remained stable (Gaston et al., 2009) while at the other, Glaucous Gulls disappeared between 1979 and 1995 (Gaston and Ouellet, 1997). At Prince Leopold Island (74˚ N, 90˚ W), monitoring has suggested an 80% decrease in breeders from 1975 to 2008, and only a few tens of pairs remain at present (A.J. Gaston, unpubl. data). Annual Christmas Bird Counts in eastern Canada suggest a 6.6% (± 1.6%) annual decline in Glaucous Gull numbers during the period 1980–2010. While the population had seemed to be increasing through the 1980s and into the 1990s, declines appeared to occur in the mid-1990s. On the other side of the North Atlantic, numbers of wintering birds in the United Kingdom have remained relatively stable over a similar time period (Balmer et al., 2013). In the western Canadian Arctic, anecdotal evidence suggests that numbers have declined, but these estimates are not based on systematic surveys.

In contrast to the declining population trends near Canadian seabird colonies, informal interviews with Inuit hunters in several local communities in Nunavut (Resolute Bay, Grise Fiord, Iqaluit, Arctic Bay) indicate that there are now many more Glaucous Gulls resident through the spring and summer than was the case in the past several decades (M.L. Mallory, unpubl. data). However, neither aerial surveys nor interviews give evidence of new breeding colonies appearing near communities.

In West Greenland, 86 colonies were surveyed more than once in the period 1988–2008, with 45 (52%) colonies unchanged, 17 (20%) increasing, and 24 (28%) declining. Local surveys provide more insights. In Upernavik municipality (72˚–75˚ N), 15 colonies supported 329 pairs in 1965, but this number had increased to 419 pairs by 1994 (Joensen and Preuss, 1972; Boertmann et al., 1996). Surveys of the fjords south of Disko Bay (67˚–69˚ N) between 1954 and 2005 suggested overall increases in gull numbers (Boertmann, 2006). In southwest Greenland (south of 61˚ N), three colonies decreased in numbers since the previous survey, while six new colonies were established, resulting in an overall increase of almost 100% in the number of pairs (Boertmann, 2004). Collectively, the few data available on Glaucous Gulls in West Greenland indicate a slight positive trend, an impression also shared with biologists by people living in Greenland during collaborative research work or informal interviews in communities.

In Iceland, data suggest that a serious decline occurred concurrent with climatic amelioration during the first half

TABLE 1. Available, conservative estimates of number of colonies, population size (breeding pairs), and population trend for Glaucous Gulls breeding in the circumpolar Arctic.

Country	Number of colonies	Breeding pairs	Population trend
USA (Alaska)	> 158	50 000	Stable or increasing
Canada	1000	> 12 000	Declining
Greenland	830	20 000 – 100 000	Stable or increasing
Iceland	245	2400	Declining
Norway			
Jan Mayen	40	> 200	–
Svalbard	230	4000	Declining (on Bjørnøya)
Russia	> 265	50 000	Stable or increasing
Total	> 2768	138 600 – 218 600	

TABLE 2. Available regional estimates for Glaucous Gull populations from the Russian Arctic.

Region	Period	Breeding pairs	Colonies	Source
SE Barents Sea	1960 – 94	1500		Bakken and Tertitski, 2000
Kolguev Island	2000s	≥ 700		Zöckler et al., 2009
Kolokolkova Bay area	2000s	900 – 1200	> 10	Mineev and Mineev, 2000; WWF Russia, unpubl. data
Novaya Zemlya	1936 – 96	1000	55	Bakken and Tertitski, 2000
Novaya Zemlya	1950s	8500		Uspensky, 1984
Franz Josef Land	2000s	2000 – 3000	> 100	M. Gavrilo, unpubl.
Severnaya Zemlya Archipelago	1990s	< 1000		de Korte et al., 1995
Wrangel Island	1970s – 80s	250 – 1000		Stishov et al., 1991
Chukotka Peninsula	1983 – 91	> 1000	50	Konyukhov et al., 1998
Russian Bering Sea	1980s – 2000s	> 1500	70	Artukhin, 2010a

of the 20th century (Gudmundsson, 1955). An increase occurred in the latter half of the 20th century until the mid-1990s (Petersen, 1998), after which a decline took place. In 2005 a census was carried out in one of two main breeding regions in Iceland, along the coast of the Breiðafjörður Bay in the west. A major decline had occurred (from 3500 pairs in 1973 to 1210 pairs in 2005), but during part of that period the population increased (Petersen, 1998). In the northwest peninsula, only 1081 pairs were estimated in 2007 – 09, although this area had previously supported an estimated 3500 pairs (Gardarsson, 1973). Around 2007, the total Icelandic Glaucous Gull population was estimated at 2400 breeding pairs, representing a population decline of around 75% since 1995 (cf. Asbirk et al., 1997).

Little is known about trends in the Svalbard population as a whole. The population on Bjørnøya has declined since 1980, when it was estimated at 2000 breeding pairs (Franeker and Luttik, 1981; Bakken and Mehlum, 1988). A survey in 2006 gave approximately 700 pairs, or a 65% reduction (Strøm, 2007). A survey of the island Hopen in 2012 indicated a 75% reduction in the number of breeding pairs, from 1000 pairs in 1985 to 239 in 2012 (S. Descamps, unpubl. data).

In the western Russian Arctic, population changes for Glaucous Gulls can be evaluated in only a few sites because of data deficiency. On Kolguev Island, a small increase has occurred, perhaps in response to increases in numbers of Barnacle Goose *Branta leucopsis*, the eggs and chicks of which constitute the principal prey in summer (Ganter et al., 1999; Zöckler et al., 2009). An increase was also suggested on Vaygach Island, southeastern Barents Sea, for the same reason (Kalyakin, 1993). A few colonies revisited on Franz Josef Land also showed an increase; an example is Rubini Rock, where numbers grew from 12 to 35 – 50 pairs during 1930 – 2013 (Demme, 1934; Belikov and Randla, 1984; Skakuj, 1992; Lunk and Joern, 2007; M. Gavrilo, unpubl. data). The small population in the Sedov Archipelago, Kara Sea, appears to be stable (Gavrilo and Volkov, 2008).

For the *pallidissimus* population in the eastern Russian Arctic, surveys between 1970 and 1991 found increases at Wrangel, Kolyuchin, and Big Diomede Islands, three large colonies in the Chukchi and northern Bering Seas (Tomkovich and Sorokin, 1983; Bogoslovskaya et al., 1988; Stishov et al., 1991; Konyukhov et al., 1998). In northern Chukotka, the population is increasing (Belyaka Spit in Kolyuchiskaya Bay; Tomkovich and Soloviev, 2012) or stable (Chaun Delta; Solovyeva, 2012). In the Chaun Delta, a stable population was observed even under conditions of increasing numbers of the Vegae Gull *Larus vegae* but decreasing numbers of Sabine's Gull *Xema sabini* (Solovyeva and Zelenskaya, 2015).

Conservation Concerns

Various conservation concerns exist for this species and differ by location across the circumpolar North.

In Alaska, Glaucous Gulls face few conservation concerns from humans primarily because of their remote breeding locations. The harvest of birds and eggs is the main issue at present, but rural residents can legally harvest Glaucous Gulls for subsistence purposes. Between

1995 and 2005, the total estimated annual harvest of Glaucous Gull eggs increased from 17 700 eggs and 800 birds to 36 700 eggs and 2100 birds (these figures may include Glaucous-winged Gulls *L. glaucescens*). This harvest, which takes place primarily in Bristol Bay and the Aleutian and Pribilof Islands, represents about 25% of the total seabird egg harvest and about 1% of the total seabird harvest in Alaska (Wohl et al., 2008).

Glaucous Gulls are taken incidentally in groundfish fisheries in the Aleutian Islands and Bering Sea regions, although mortality estimates combine all large gull species. Bycatch of these gulls decreased from 2400 birds per year (22% of seabird bycatch) in 1993 to 800 birds per year in 2010 (derived from NOAA, 2006, 2011).

In the Aleutian Islands, increasing vessel traffic through the Great Circle route could increase the risk of shipping accidents and spills. At the northern end of the Bering Sea, longer periods of ice-free conditions, oil and gas exploration, and predicted increases in vessel traffic could increase impacts and risks.

In Canada, changes in numbers, especially the steep decline at Prince Leopold Island, have created concern. Reproductive success at Prince Leopold Island has been low compared to Coats Island, where the population is stable (Gaston et al., 2005, 2009). Among Canadian Arctic marine birds, Glaucous Gulls have relatively high contaminant levels (Braune et al., 2002; Buckman et al., 2004), but not as high as those in Svalbard, where negative effects on physiology and behavior have been found (Bustnes et al., 2003; Bustnes, 2006; Verreault et al., 2007, 2008).

Studies from two Canadian colonies suggest relatively low survival rates for Glaucous Gulls (Gaston et al., 2009; Allard et al., 2010). Some years with high mortality have been reported, perhaps related to gulls' scavenging on carcasses infected with avian cholera (Allard et al., 2010). Some Glaucous Gulls have also been found dead but apparently in good physical condition, with no obvious cause of mortality (Mallory et al., 2009a).

There are no immediate concerns for the Glaucous Gull population in Greenland. Hunting is allowed outside the breeding season, and egg collecting is allowed until 15 June. Commercial egging of gulls (Great Black-backed Gulls *Larus marinus* and Glaucous Gulls) was allowed in spring 2009, which may give reason for some concern, but no information is available on the numbers harvested. In the long run, climate change may negatively affect the population in the southwestern parts of Greenland, where the temperate Herring Gull, and especially Lesser Black-backed gull *L. fuscus*, have established breeding populations in recent decades (Boertmann, 2008).

In Iceland, the large decline in Glaucous Gulls remains unexplained. Adults and eggs are harvested, but this harvest has diminished in recent decades. From 1995 to 2002, on average 3847 birds (range: 2471 – 5496) were killed annually as pest species, but this average declined in 2004 – 11 to 1722 birds (range: 1124 – 2407). This harvest was less than half that in the preceding period and mirrors the observed population decline (Petersen et al., 2014). Better care of community dumps, closure of offal disposals from fish processing plants, and better control of offal and bycatch from fishing vessels may have contributed to the observed decline of gulls in recent decades by reducing food availability. Declines at some colonies are believed to be due to Arctic foxes *Vulpes lagopus*, the population of which has greatly increased in recent decades (Hersteinsson, 2004). However, fox predation of eggs and chicks is not believed to have caused the population decline, but rather to have resulted in re-distribution of breeding pairs. The hybridization of Herring Gulls with Glaucous Gulls (Ingólfsson, 1970; Vigfúsdóttir et al., 2008; Pálsson et al., 2009) and Herring Gulls' continually approaching the core Glaucous Gull breeding regions (Petersen, 1998) are causes for real concern regarding the status of Glaucous Gulls as a separate species.

In Norway, contaminants and food shortages have been suggested as the main causes for concern. Glaucous Gulls on Bjørnøya, especially those specializing on eggs and chicks of other seabirds, accumulate high levels of organic contaminants. Effects on hormone production and the immune system have been documented, as well as reduced reproductive success and adult survival (e.g., Bustnes et al., 2003; Verreault et al., 2010; Erikstad and Strøm, 2012). Significant numbers of dead or dying birds have been found annually near the breeding colonies on Bjørnøya. Autopsies and analyses of environmental contaminants have shown that the birds were emaciated and contained high levels of OCP, PCB, and PBDE in the liver and brain (Sagerup et al., 2009). The high levels of contaminants may contribute to the death of weakened individuals, although it is not known whether the emaciation is triggered by high levels of contaminants or by environmental factors such as food shortage (Sagerup et al., 2009). Changes in food availability and predation or competition by a growing population of Arctic foxes and Great Skua *Stercorarius skua* may also be factors influencing the decline of the Bjørnøya Glaucous Gull population (Strøm, 2007; Erikstad and Strøm, 2012). Nothing is known about trends in the Jan Mayen breeding population.

In western Russia, most gulls breed in remote, uninhabited regions, and thus there have been few concerns for their populations. Much of the population breeds within specially protected areas (strict nature reserves or refuges) such as the Franz Josef Land Refuge, the Great Arctic Reserve, the Lena Delta Reserve, or the Wrangel Island Reserve. However, in recent years several adult Glaucous Gulls found dead on Franz Josef Land had no visible external signs explaining mortality (M. Gavrilo, unpubl. data). It is suspected that toxic contamination may explain these deaths in a situation similar to that on Svalbard.

In eastern Russia, gulls breed in regions of low human activity. Bycatch in long-line fisheries has increased in winter, mainly in the Kamchatka waters (Artukhin, 2010b). Eggs are harvested in seabird colonies in Chukotka near some settlements, but the scale of the Glaucous Gull egg harvest is unknown (Portenko, 1989).

DISCUSSION

Despite the position of the Glaucous Gull at the top of Arctic marine food webs and its role as a sentinel species for the health of the Arctic marine ecosystem (Braune et al., 2002; Sagerup et al., 2009), we have little knowledge of its population size and breeding distribution in the Arctic countries. The main exceptions are Svalbard and Iceland, where new censuses have led to better knowledge. In Alaska, Russia, and Canada, colonies are widely scattered in remote areas and often consist of single pair or a few pairs, which makes full coverage of distribution and population size difficult, even impossible, to achieve. At present, the total Arctic population is estimated at 138 600 to 218 600 breeding pairs (277 200 to 437 200 individuals); possibly the largest proportion is in Greenland, but significant populations are also found in Russia and Canada.

Although some overriding factors appear to drive consistent, long-term population trends in Arctic marine birds (Irons et al., 2008), shorter term, regional differences in population trends within a species appear typical, as do simultaneous, different trajectories among species. For example, Thick-billed Murre *Uria lomvia* populations are increasing in Canada (Gaston et al., 2012) but declining in Greenland (Merkel et al., 2014), while Lesser Black-backed Gulls are increasing in Greenland (Boertmann, 2008) and Ivory Gulls *Pagophila eburnea* have declined in both Canada (Gilchrist et al., 2008) and Greenland (Gilg et al., 2009). Black-legged Kittiwake *Rissa tridactyla* numbers have declined in Greenland (Labansen et al., 2010), Norway (Krasnov et al., 2007; Cury et al., 2011), and northwestern Russia (Krasnov et al., 2007), but in Arctic Canada they are apparently increasing (Mallory et al., 2009b). Northern Fulmar *Fulmarus glacialis* numbers appear to be in slow decline in Canada (Gaston et al., 2012), and perhaps across the North Atlantic (e.g., JNCC, 2013). Several seabird species have shown serious declines in Iceland in recent years, such as European Shag *Phalacrocorax aristotelis*, Northern Fulmar, Black-legged Kittiwake, Razorbill *Alca torda*, Thick-billed Murre, Common Murre *Uria aalge*, and Black-headed Gull *Chroicocephalus ridibundus* (Petersen and Thorstensen, 2005; Gardarsson, 2006; Gardarsson and Petersen, 2009). Conversely others have increased, such as Northern Gannet *Morus bassanus*, Great Cormorant *Phalacrocorax carbo*, and Mew Gull *Larus canus* (Gardarsson, 2008a, b; Thorstensen and Petersen, 2013).

In the case of the Glaucous Gull, the population has declined drastically in Canada, Iceland, and Svalbard (at least on Bjørnøya) in recent decades, although undocumented redistribution may account for some local changes. Reasons for the Glaucous Gull declines remain largely unexplained, although some possible causal factors have been identified. On Bjørnøya (Svalbard), the population decline has been related to contaminants (Bustnes et al., 2003; Sagerup et al., 2009; Verreault et al., 2010; Erikstad and Strøm, 2012). At some sites in Canada, apparent adult annual survival is 84%, which is somewhat low for a large gull (Gaston et al., 2009; Allard et al., 2010). Moreover, a significant number of adult-plumaged birds have been found dead near colonies without obvious signs of cause (e.g., Mallory et al., 2009a), as was similarly observed in Svalbard. No autopsies have been performed on the Canadian birds, but these mortality events could be related to contaminants. The first analogous cases of potential contaminant mortality were observed in recent years in the Russian part of the northern Barents Sea. In Iceland, both redistribution and declines seem to have occurred; the latter are probably due to reduced food availability resulting from better controls on fish offal and bycatch.

In contrast to examples from the North Atlantic region, the limited information from the North Pacific suggests different trends. The Russian situation remains largely unknown, but there are indications of stability or even local increases in Glaucous Gull numbers. In Alaska, the available information, though limited, indicates a stable breeding population.

Clearly there are changes underway for some breeding regions or subpopulations of this species that may be related to proximate anthropogenic factors (e.g., development of community dumps, changes in fishery discards; Bicknell et al., 2013), local conditions (e.g., increased food base, such as Barnacle Goose) and other factors that may be attributable to broader, regional environmental change (e.g., competition with other gulls due to range shifts with global warming; Boertmann, 2008). The Glaucous Gull is a top predator and scavenger and a species that can play a major role in local ecosystems (e.g., Gilchrist and Gaston, 1997; Gaston and Elliott, 2013); therefore, a better understanding of Glaucous Gull populations and trends will yield greater insights into the status of Arctic marine ecosystems.

We therefore recommend that future research should:

- Undertake more extensive and systematic surveys of Glaucous Gull colonies for better information on distribution, numbers, and trends. This information is needed to establish and improve management (Greenland, Iceland, Russia) and to enhance programs that monitor breeding (Alaska, Canada, Norway).

- Examine Glaucous Gull biology during the non-breeding period to determine the extent to which factors that affect birds during that part of their annual cycle may be responsible for population declines. Such studies could include winter (including at-sea) surveys, tracking studies for population connectivity, and studies of non-breeding ecology, such as food habits and exposure to contaminants. Studies of the non-breeding season may be particularly important as climate change reduces annual sea ice extent and duration in the Arctic.

- Enact research and monitoring programs on two of the poorly studied subspecies of Glaucous Gull, *hyperboreus* (in the European Arctic) and *leuceretes* (in

West Greenland). Both are listed on the Action Plan of the African-Eurasian Waterbird Agreement (AEWA, 2012) as requiring international attention. In particular, delineation between subspecies needs to be revisited.

The Glaucous Gull is one of 22 Arctic seabird species proposed for priority circumpolar monitoring by the Arctic countries as a species of international responsibility (Petersen et al., 2008). Collaborative conservation efforts, especially by the Arctic countries, are needed to obtain a better understanding of the population changes taking place in Glaucous Gull populations and possible causal factors. Given the regional differences in its population trends, the Glaucous Gull should be a suitable species through which to examine the factors affecting these different trends.

REFERENCES

AEWA (African-Eurasian Waterbird Agreement). 2012. Adoption of amendments to the AEWA Action Plan (Resolution 5.6.). http://www.unep-aewa.org/en/document/adoption-amendments-aewa-action-plan-0

Allard, K.A., Gilchrist, H.G., Breton, A.R., Gilbert, C.D., and Mallory, M.L. 2010. Apparent survival of adult Thayer's and Glaucous Gulls nesting sympatrically in the Canadian High Arctic. Ardea 98(1):43–50. http://dx.doi.org/10.5253/078.098.0106

AMAP (Arctic Monitoring and Assessment Programme). 2005. AMAP Assessment 2002: Heavy metals in the Arctic. Oslo, Norway: AMAP. 265 p. http://www.amap.no/documents/doc/amap-assessment-2002-heavy-metals-in-the-arctic/97

Artukhin, Yu.B. 2010a. Состав и распределение гнездящихся морских птиц [Composition and distribution of nesting marine birds]. In: Makarevich, P.R., ed. Current status of the ecosystem of the Western Bering Sea. Rostov-on-Don: South Science Center, Russian Academy of Sciences Publication. 256–290.

———. 2010b. Рыболовство и его экологические последствия [Fishery and its environmental consequences: Marine birds by-catch at fishery]. In: Makarevich, P.R., ed. Current status of the ecosystem of the Western Bering Sea. Rostov-on-Don: South Science Center, Russian Academy of Sciences Publication. 317–329.

Asbirk, S., Berg, L., Hardeng, G., Koskimies, P., and Petersen, A. 1997. Population sizes and trends of birds in the Nordic countries: 1978–1994. TemaNord 1997:614. Copenhagen: Nordic Council of Ministers. 88 p.

Bakken, V., and Mehlum, F. 1988. AKUP – Sluttrapport sjøfuglundersøkelser nord for 74° N/Bjørnøya. [AKUP – Final report of the seabird surveys north of N74/Bjørnøya]. Norsk Polarinstitutt Rapportserie Nr. 44. Oslo. 179 p.

Bakken, V., and Tertitski, G.M. 2000. Glaucous Gull *Larus hyperboreus*. In: Anker-Nilssen, T., Bakken, V., Strøm, H., Golovkin, A.N., Bianki, V.V., and Tatarinkova, I.P., eds. The status of marine birds breeding in the Barents Sea region. Report No. 113. Tromsø: Norwegian Polar Institute. 94–96.

Bakken, V., Runde, O., and Tjørve, E. 2003. Polarmåke *Larus hyperboreus*, Glaucous Gull. In: Norsk ringmerkingsatlas, Vol. 1. Lommer – Alkefugler [Norwegian bird ringing atlas, Vol. 1. Divers – Auks] (in Norwegian, English summary). Stavanager: Stavanger Museum. 353–357.

Balmer, D., Gillings, S., Caffrey, B., Swann, B., Downie, I., and Fuller, R. 2013. Bird atlas 2007–11: The breeding and wintering birds of Britain and Ireland. Thetford, United Kingdom: BTO Books. 718 p.

Banks, R.C. 1986. Subspecies of the Glaucous Gull, *Larus hyperboreus* (Aves: Charadriiformes). Proceedings of the Biological Society of Washington 99:149–159.

Belikov, S.E., and Randla, T.E. 1984. К орнитофауне острова Гукера (Земля Франца-Иосифа) [To the ornithofauna of the Hooker Island (Franz Josef Land)]. Ornitologiya (Moscow) 19:174–175.

Bicknell, A.W.J., Oro, D., Camphuysen, C.J., and Votier, S.C. 2013. Potential consequences of discard reform for seabird communities. Journal of Applied Ecology 50(3):649–658. http://dx.doi.org/10.1111/1365-2664.12072

Boertmann, D. 1994. An annotated checklist to the birds of Greenland. Meddelelser om Grønland Bioscience 38. 64 p.

———. 2004. Seabird colonies and moulting harlequin ducks in South Greenland: Results of a survey in July 2003. Research Notes from NERI No. 191. Roskilde, Denmark: National Environmental Research Institute. 34 p. http://www.dmu.dk/1_viden/2_Publikationer/3_arbejdsrapporter/rapporter/AR191.pdf

———. 2006. Optælling af ridekolonier i Disko Bugt, Arfersiorfik Fjord og Nordre Strømfjord i 2005 [Censusing of Kittiwake colonies in Disko Bay, Arfersiorfik Fjord and Nordre Strømfjord] (in Danish, English summary). Arbejdsrapport fra Danmarks Miljøundersøgelser Nr. 225. Roskilde, Denmark: National Environmental Research Institute. http://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR225.pdf

———. 2008. The lesser black-backed gull, *Larus fuscus*, in Greenland. Arctic 61(2):129–133. http://dx.doi.org/10.14430/arctic17

Boertmann, D., Mosbech, A., Falk, K., and Kampp, K. 1996. Seabird colonies in western Greenland. NERI Technical Report 170. Roskilde, Denmark: National Environmental Research Institute. 148 p.

Boertmann D., Lyngs, P., Merkel, F.R., and Mosbech, A. 2004. The significance of Southwest Greenland as winter quarters for seabirds. Bird Conservation International 14(2):87–112. http://dx.doi.org/10.1017/S0959270904000127

Bogoslovskaya, L.S., Zvonov, B.M., and Konyukhov, N.B. 1988. Птичьи базары восточного побережья Чукотского полуострова [Seabird colonies of eastern Chukotka Peninsula]. In: Andreev, A.V., and Kondratyev, A.Y., eds. Studies and protection of birds in northern ecosystems. Vladivostok: Far-Eastern Branch, USSR Academy of Science. 24–27.

Braune, B.M., Donaldson, G.M., and Hobson, K.A. 2002. Contaminant residues in seabird eggs from the Canadian Arctic. II. Spatial trends and evidence from stable isotopes for intercolony differences. Environmental Pollution 117(1):133–145. http://dx.doi.org/10.1016/S0269-7491(01)00186-5

Brown, R.G.B., Nettleship, D.N., Germain, P., Tull, C.E., and Davis, T. 1975. Atlas of eastern Canadian seabirds. Ottawa: Canadian Wildlife Service.

Buckman, A.H., Norstrom, R.J., Hobson, K.A., Karnovsky, N.J., Duffe, J., and Fisk, A.T. 2004. Organochlorine contaminants in seven species of Arctic seabirds from northern Baffin Bay. Environmental Pollution 128(3):327–338. http://dx.doi.org/10.1016/j.envpol.2003.09.017

Burfield, I., and van Bommel, F. 2004. Birds in Europe: Population estimates, trends and conservations status. BirdLife Conservation Series 12. Cambridge: BirdLife International. 374 p.

Bustnes, J.O. 2006. Pinpointing potential causative agents in mixtures of persistent organic pollutants in observational field studies: A review of Glaucous Gull studies. Journal of Toxicology and Environmental Health, Part A 69(1-2):97–108. http://dx.doi.org/10.1080/15287390500259301

Bustnes, J.O., Erikstad, K.E., Skaare, J.U., Bakken, V., and Mehlum, F. 2003. Ecological effects of organochlorine pollutants in the Arctic: A study of the Glaucous Gull. Ecological Applications 13(2):504–515. http://dx.doi.org/10.1890/1051-0761(2003)013[0504:EEOOPI]2.0.CO;2

Cleemann, M., Riget, F., Paulsen, G.B., and Dietz, R. 2000. Organochlorines in Greenland Glaucous Gulls (*Larus hyperboreus*) and Iceland Gulls (*Larus glaucoides*). Science of the Total Environment 245(1-3):117–130. http://dx.doi.org/10.1016/S0048-9697(99)00437-4

Cramp, S. 1983. *Larus hyperboreus* Glaucous Gull. In: Birds of the Western Palearctic. Vol. III: Waders to gulls. Oxford: Oxford University Press. 840–849.

Cury, P.M., Boyd, I.L, Bonhommeau, S., Anker-Nilssen, T., Crawford, R.J.M., Furness, R.W., Mills, J.A., et al. 2011. Global seabird response to forage fish depletion – one-third for the birds. Science 334(6063):1703–1706. http://dx.doi.org/10.1126/science.1212928

de Knijff, P., Helbig, A., and Liebers, D. 2005. The Beringian connection: Speciation in the Herring Gull assemblage of North America. Birding 37:402–411. http://gull-research.org/papers/Birding%2008.05%20p402%20to%20411-0.pdf

de Korte, J., Volkov, A.E., and Gavrilo, M.V. 1995. Bird observations in Severnaya Zemlya, Siberia. Arctic 48(3):222–234. http://dx.doi.org/10.14430/arctic1244

Demme, N.P. 1934. Птичий базар на скале Рубини (остров Гукера, Земля Франца-Иосифа) [Seabirds colony on the Rubini Rock (Hooker Island, Franz Josef Land)]. Transactions of the Arctic Institute 11:55–86.

Descamps, S., Strøm, H., Moe, B., Gabrielsen, G.W., Sagerup, K., and Bustnes, J.O. 2013. Status and trend of Glaucous Gulls in Kongsfjorden, Spitsbergen. Final report –Svalbard Miljøvernfond. 18 p. http://www.sysselmannen.no/Documents/Svalbard_Miljovernfond_dok/Prosjekter/Rapporter/11-75%20Glaucous%20gulls%20-%20Final%20report.pdf

Erikstad, K.E., and Strøm, H. 2012. Effekter av miljøgifter på bestanden av polarmåke på Bjørnøya [Effects of contaminants on the population of Glaucous Gull on Bjørnøya]. Norsk Polarinstitutt Kortrapport Nr. 25. 16 p.

Fifield, D.A., Lewis, K.P., Gjerdrum, C., Robertson, G.J., and Wells, R. 2009. Offshore Seabird Monitoring Program. Environment Studies Research Funds Report No. 183. St. John's, Newfoundland and Labrador: ESRF.

Franeker, J.A., and Luttik, R. 1981. Report on the *Fulmarus glacialis*-Expedition Bear Island: July–August 1980. Verslagen en technische gegevens no. 32. Amsterdam: Institut voor Taxonomische Zoölogie (Zoölogisch Museum), Universiteit van Amsterdam. 21 p.

Ganter, B., Larsson, K., Syroechkovsky, E.V., Litvin, K.E., Leito, A., and Madsen, J. 1999. Barnacle Goose *Branta leucopsis*: Russia/Baltic. In: Madsen, J., Cracknell, G., and Fox, T., eds. Goose populations of the Western Palearctic. A review of status and distribution. Wetlands International Publication 48. Wageningen. 271–283.

Gardarsson, A. 1973. Fuglastofnar og selir á Breiðafirði [Bird and seal populations in the Breiðafjörður region (W-Iceland)]. Náttúrufræðistofnun Íslands. Unpubl. report, October 1973. 26 p. Available from Þjóðarbókhlaðan [National and University Library of Iceland], Arngrimsgata 3, 107 Reykjavik, Iceland.

———. 2006. Nýlegar breytingar á fjölda íslenskra bjargfugla [Recent changes in numbers of cliff-breeding seabirds in Iceland] (in Icelandic, English summary). Bliki 27:13–22.

———. 2008a. Dílaskarfsbyggðir 1994–2008 [Distribution and numbers of the Great Cormorant *Phalacrocorax carbo* in Iceland in 1994–2008] (in Icelandic, English summary). Bliki 29:1–10.

———. 2008b. Súlutalning 2005–2008 [A census of the Northern Gannet in Iceland, 2005–2008] (in Icelandic, English summary). Bliki 29:19–22.

Gardarsson, A., and Petersen, A. 2009. Íslenski toppskarfastofninn [The Icelandic population of European Shag] (Icelandic, English summary). Bliki 30:9–25.

Gaston, A.J., and Elliott, K.H. 2013. Effects of climate-induced changes in parasitism, predation and predator-predator interactions on reproduction and survival of an Arctic marine bird. Arctic 66(1):43–51. http://dx.doi.org/10.14430/arctic4265

Gaston, A.J., and Ouellet, H. 1997. Birds and mammals of Coats Island, N.W.T. Arctic 50(2):101–118. http://dx.doi.org/10.14430/arctic1094

Gaston, A.J., Gilchrist, H.G., and Mallory, M.L. 2005. Variation in ice conditions has strong effects on the breeding of marine birds at Prince Leopold Island, Nunavut. Ecography 28(3):331–344. http://dx.doi.org/10.1111/j.0906-7590.2005.04179.x

Gaston, A.J., Descamps, S., and Gilchrist, H.G. 2009. Reproduction and survival of Glaucous Gulls breeding in an Arctic seabird colony. Journal of Field Ornithology 80(2):135–145. http://dx.doi.org/10.1111/j.1557-9263.2009.00215.x

Gaston, A.J., Mallory, M.L., and Gilchrist, H.G. 2012. Populations and trends of Canadian Arctic seabirds. Polar Biology 35(8):1221–1232. http://dx.doi.org/10.1007/s00300-012-1168-5

Gavrilo, M.V., and Bakken, V. 2000. The Kara Sea. In: Bakken, V., ed. Seabird colony databases of the Barents Sea Region and the Kara Sea, 2nd ed. Norsk Polarinstitutt Rapportserie Nr. 115. 53–62.

Gavrilo, M.V., and Volkov, A.E. 2008. Современное состояние популяций и динамика населения птиц района архипелага Седова, Северная Земля [Status of bird population and dynamics of bird numbers around the Sedov Archipelago, Severnaya Zemlya]. In: Nature of the shelf and archipelagos of the European Arctic. Materials of the International Scientific Conference, Moscow: GEOS. 67–74.

Gilchrist, H.G. 2001. Glaucous Gull (*Larus hyperboreus*). In: Poole, A., ed. The birds of North America online. Ithaca, New York: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/573

Gilchrist, H.G., and Gaston, A.J. 1997. Effects of murre nest site characteristics and wind conditions on predation by Glaucous Gulls. Canadian Journal of Zoology 75(4):518–524. http://dx.doi.org/10.1139/z97-064

Gilchrist, H.G., and Robertson, G.J. 1999. Population trends of gulls and Arctic Terns nesting in the Belcher Islands, Nunavut. Arctic 52(4):325–331. http://dx.doi.org/10.14430/arctic939

———. 2000. Observations of marine birds and mammals wintering at polynyas and ice edges in the Belcher Islands, Nunavut, Canada. Arctic 53(1):61–68. http://dx.doi.org/10.14430/arctic835

Gilchrist, H.G., Strøm, H., Gavrilo, M.V., and Mosbech, A. 2008. International Ivory Gull conservation strategy and action plan. CAFF Technical Report No. 18. Akureyri, Iceland: CAFF International Secretariat, Circumpolar Seabird Group (CBird).

Gilg, O., Boertmann, D., Merkel, F., Aebischer, A., and Sabard, B. 2009. Status of the endangered Ivory Gull, *Pagophila eburnea*, in Greenland. Polar Biology 32(9):1275–1286. http://dx.doi.org/10.1007/s00300-009-0623-4

Gudmundsson, F. 1955. Íslenzkir fuglar XI. Hvítmáfur (*Larus hyperboreus*) [Icelandic Birds XI. The Glaucous Gull (*Larus hyperboreus*)]. Natturufraedingurinn 25(1):24–35.

Hamer, K.C., Schreiber, E.A., and Burger, J. 2002. Breeding biology, life histories, and life history–environment interactions in seabirds. In: Schreiber, E.A., and Burger, J., eds. Biology of marine birds. New York: CRC Press. 217–261.

Hersteinsson, P. 2004. Tófa [Arctic fox.] In: Íslensk spendýr [Icelandic mammals]. Vaka-Helgafell, Reykjavik. 74–85.

Ingólfsson, A. 1970. Hybridizaion of Glaucous Gulls *Larus hyperboreus* and Herring Gulls *L. argentatus* in Iceland. Ibis 112(3):340–362. http://dx.doi.org/10.1111/j.1474-919X.1970.tb00112.x

———. 1982. Máfar, kjóar og skúmar [Gulls and skuas.] In: Gardarsson, A., ed. Fuglar [Birds]. Rit Landverndar 8. Reykjavík. 61–76.

Irons, D.B., Anker-Nilssen, T., Gaston, A.J., Byrd, G.V., Falk, K., Gilchrist, G., Hario, M., et al. 2008. Fluctuations in circumpolar seabird populations linked to climate oscillations. Global Change Biology 14(7):1455–1463. http://dx.doi.org/10.1111/j.1365-2486.2008.01581.x

Joensen, A.H., and Preuss, N.O. 1972. Report on the ornithological expedition to Northwest Greenland 1965. Meddelelser om Grønland 191. 58 p.

JNCC (Joint Nature Conservation Committee). 2013. Seabird population trends and causes of change: 1986–2013 report. Aberdeen: JNCC. http://www.jncc.defra.gov.uk/page-3201

Kalyakin, V.N. 1993. Фауна птиц и млекопитающих авифауны Нвоземельского региона и оценка ее состояния [Fauna of birds and mammals of the Novaya Zemlya region and an assessment of their condition]. In: Boyarsky, P.V., ed. Novaya Zemlya: Proceedings of the Marine Arctic Complex Expedition. Vol. 2:23–90.

Kokhanov, V.D. 1981. Современные ареалы чаек на Белом море и Мурмане [Current ranges of gulls in the White Sea and on Murman]. In: Flint, V.E., ed. Scientific background for surveys of colonial breeding grounds of waterbirds. Moscow: Nauka. 63–64.

Konyukhov, N.B., Bogoslovskaya, L.S., Zvonov, B.M., and van Pelt, T.I. 1998. Seabirds of the Chukotka Peninsula, Russia. Arctic 51(4):315–329. http://dx.doi.org/10.14430/arctic1074

Krasnov, Y.V., Barrett, R.T., and Nikolaeva, N.G. 2007. Status of Black-legged Kittiwakes (*Rissa tridactyla*), Common Guillemots (*Uria aalge*) and Brunnich's Guillemots (*U. lomvia*) in Murman, north-west Russia, and Varanger, north-east Norway. Polar Research 26(2):113–117. http://dx.doi.org/10.1111/j.1751-8369.2007.00015.x

Labansen, A.L., Merkel, F., Boertmann, D., and Nyeland, J. 2010. Status of the Black-legged Kittiwake (*Rissa tridactyla*) breeding population in Greenland, 2008. Polar Research 29(3):391–403. http://dx.doi.org/10.1111/j.1751-8369.2010.00169.x

Larned, W., Stehn, R., and Platte, R. 2011. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska 2010. Soldotna and Anchorage: U.S. Fish and Wildlife Service. 54 p. http://www.north-slope.org/assets/images/uploads/acp2010rpt_final.pdf

Liebers, D., de Knijff, P., and Helbig, A.J. 2004. The Herring Gull complex is not a ring species. Proceedings of the Royal Society of London B: Biological Sciences 271(1542):893–901. http://dx.doi.org/10.1098/rspb.2004.2679

Lunk, S., and Joern, D. 2007. Ornithological observations in the Barents and Kara Seas during the summers of 2003, 2004 and 2005. Russian Ornithologica Journal 16(370):999–1019.

Lyngs, P. 2003. Migration and winter ranges of birds in Greenland. Copenhagen: Dansk Ornitologisk Forenings Tidsskrift 97. 167 p.

Mallory, M.L., Gaston, A.J., and Gilchrist, H.G. 2009a. Sources of breeding season mortality in Canadian Arctic seabirds. Arctic 62(3):333–341. http://dx.doi.org/10.14430/arctic154

Mallory, M.L., Akearok, J.A., and Gaston, A.J. 2009b. Status of High Arctic Black-legged Kittiwake (*Rissa tridactyla*) colonies in Barrow Strait, Nunavut, Canada. Arctic 62(1):96–101. http://dx.doi.org/10.14430/arctic116

McKinnon, L., Gilchrist, H.G., and Fifield, D. 2009. A pelagic seabird survey of Arctic and sub-Arctic Canadian waters during fall. Marine Ornithology 37:77–84.

Mehlum, F., and Bakken, V. 1994. Seabirds in Svalbard (Norway): Status, recent changes and management. In: Nettleship, D.N., Burger, J., and Gochfeld, M., eds. Seabirds on islands: Threats, case studies and action plans. BirdLife Conservation Series No. 1. Cambridge: BirdLife International. 155–171.

Merkel, F., Labansen, A.L., Boertmann, D., Mosbech, A., Egevang, C., Falk, K., Linnebjerg, J.F., Frederiksen, M., and Kampp, K. 2014. Declining trends in the majority of Greenland's Thick-billed Murre (*Uria lomvia*) colonies 1981–2011. Polar Biology 37(8):1061–1071. http://dx.doi.org/10.1007/s00300-014-1500-3

Mineev, Yu.N., and Mineev, O.Yu. 2000. Орнитофауна бассейна реки Нерута и Колоколковой губы [Ornithofauna of Neruta river basin and Kolokolkova bay]. Russian Journal of Ornithology 112:9–16.

NOAA (National Oceanic and Atmospheric Administration). 2006. Summary of seabird bycatch in Alaskan groundfish fisheries, 1993 through 2004 (Updated 13 April 2006). http://www.afsc.noaa.gov/refm/reem/doc/Seabird%20bycatch%20tables%201993-2004_13April2006.pdf

———. 2011. Preliminary seabird bycatch estimates for Alaskan groundfish fisheries, 2007–2010 (August 2011). http://www.afsc.noaa.gov/refm/reem/Seabirds/Seabird%20bycatch%202007%20to%202010_Alaskan%20Gndfish_PrelimReport.pdf

NPPSD. 2014. North Pacific Pelagic Seabird Database. Anchorage: U.S. Geological Survey, Alaska Science Center and U.S. Fish and Wildlife Service. http://alaska.usgs.gov/science/biology/nppsd/index.php

Pálsson, S., Vigfúsdóttir, F., and Ingólfsson, A. 2009. Morphological and genetic patterns of hybridization of Herring Gulls (*Larus argentatus*) and Glaucous Gulls (*L. hyperboreus*) in Iceland. Auk 126(2):376–382. http://dx.doi.org/10.1525/auk.2009.08080

Petersen, A. 1983. Fuglatalningar að vetrarlagi: Saga og árangur [Icelandic Christmas bird counts: Historical aspects and results] (in Icelandic, English summary). Bliki 2:28–42.

———. 1998. Íslenskir fuglar [Icelandic birds]. Reykjavík: Vaka-Helgafell. 312 p.

Petersen, A., and Thorstensen, S. 2005. Vöktun hettumáfs í Eyjafirði 1995–2000 [Monitoring of Black-headed Gulls *Larus ridibundus* in Eyjafjörður, (N-Iceland) 1995 and 2000] (in Icelandic, English summary). Natturufraedingurinn 73(1-2):39–46.

Petersen, A., Irons, D., Anker-Nilssen, T., Artukhin, Y., Barrett, R., Boertmann, D., Egevang, C., et al. 2008. Framework for a Circumpolar Arctic Seabird Monitoring Network. CAFF CBMP Report No. 15. Akureyri, Iceland: CAFF International Secretariat.

Petersen, A., Thorstensen, S., and Thórisson, B. 2014. Útbreiðsla og breytingar á fjölda hvítmáfa á Íslandi [Distribution and changes in numbers of Glaucous Gulls *Larus hyperboreus* breeding in Iceland] (in Icelandic, English summary). Natturufraedingurinn 84(3-4):153–163.

Platte, R.M., and Stehn, R.A. 2009. Abundance, distribution, and trend of waterbirds on Alaska's Yukon-Kuskokwim Delta coast based on 1985 to 2009 aerial surveys. Anchorage: U.S. Fish and Wildlife Service. Unpubl. annual survey report. http://www.arlis.org/docs/vol1/A/389006300/389006300-2009. pdf

Portenko, L.A. 1989. Birds of the Chukchi Peninsula and Wrangel Island. Translated from Russian by P.M. Rao. Vol. 2. Washington, D.C.: Smithsonian Institution and National Science Foundation. 379 p.

Riget, F., and Dietz, R. 2000. Temporal trends of cadmium and mercury in Greenland marine biota. Science of the Total Environment 245(1-3):49–60. http://dx.doi.org/10.1016/S0048-9697(99)00432-5

Riget, F., Dietz, R., Johansen, P., and Asmund, G. 2000. Lead, cadmium, mercury and selenium in Greenland marine biota and sediments during AMAP phase 1. Science of the Total Environment 245(1-3):3–14. http://dx.doi.org/10.1016/S0048-9697(99)00429-5

Rogacheva, E.V. 1992. The birds of central Siberia. Husum, Germany: Husum Druck. 737 p.

Sagerup, K., Helgason, L.B., Polder, A., Strøm, H., Josefsen, T.D., Skåre, J.U., and Gabrielsen, G.W. 2009. Persistent organic pollutants and mercury in dead and dying Glaucous Gulls (*Larus hyperboreus*) at Bjørnøya (Svalbard). Science of the Total Environment 407(23):6009–6016. http://dx.doi.org/10.1016/j.scitotenv.2009.08.020

SCRIB. 2009. Seabird colony registry of the Barents and White Seas. Unpubl. database. Norwegian Polar Institute, Fram Centre, NO-9296 Tromsø, Norway.

Seabird Information Network. 2012. North Pacific seabird data portal. http://axiom.seabirds.net/maps/north-pacific-seabirds/

Skakuj, M. 1992. Seabirds of Tikhaya Bay, summer 1991. In: Gjertz, I., and Mørkved, B. Environmental studies from Franz Josef Land, with emphasis on Tikhaia Bay, Hooker Island. Meddelelser 120. Oslo: Norwegian Polar Institute. 63–65.

Solovyeva, D.V. 2012. Многолетняя динамика фауны птиц дельты рр. Чаун-Пучевеем (Западная Чукотка) и возможные причины изменения численности отдельных видов [Long-term population dynamics of the bird fauna in the Chaun and Pucheveyem Delta, West Chukotka, Russia, and possible causes of changes in selected species numbers]. Bulletin of the North-East Science Center, Russian Academy of Science Far East Branch 4:57–65.

Solovyeva, D.V., and Zelenskaya, L.A. 2015. Изменения состава и численности чаек в тундровых колониях на западной Чукотке за последние 40 лет [Changes in species composition and numbers of gulls in tundra colonies on Western Chukotka during last 40 years]. Zoologicheskiy zhurnal 94(1):68–75.

Stepanyan, L.S. 2003. Конспект орнитологической фауны России и сопредельных территорий [Conspectus of the ornithological fauna of Russia and adjacent territories (within the borders of the USSR as a historic region)]. Moscow: PTC "Akademkniga." 808 p.

Stishov, M.S., Pridatko, V.I., and Baranyuk, V.V. 1991. Птицы острова Врангеля [Birds of Wrangel Island]. Novosibirsk: Nauka. 253 p.

Strøm, H. 2006a. Glaucous Gull *Larus hyperboreus*. In: Kovacs, K.M., and Lydersen, C., ed. Birds and mammals of Svalbard. Polarhåndbok No. 13. Tromsø: Norwegian Polar Institute. 141–143.

———. 2006b. Mapping of coastal seabirds in Svalbard. In: Anker-Nilssen, T., Barrett, R.T., Bustnes, J.O., Erikstad, K.E., Fauchald, P., Lorentsen, S.-H., Steen, H., Strøm, H., Systad, G.H., and Tveraa, T. SEAPOP studies in the Lofoten and Barents Sea area in 2005. NINA Report 127. 29–30. http://www.nina.no/archive/nina/pppbasepdf/rapport/2006/127.pdf

———. 2007. Bjørnøya. In: Anker-Nilssen, T., Barrett, R.T., Bustnes, J.O., Erikstad, K.E., Fauchald, P., Lorentsen, S.-H., Steen, H., Strøm, H., Systad, G.H., and Tveraa, T. 2007. SEAPOP studies in the Lofoten and Barents Sea area in 2006. NINA Report 249. 31–32. http://www.nina.no/archive/nina/pppbasepdf/rapport/2007/249.pdf

Thorstensen, S., and Petersen, A. 2013. Enn fjölgar stormmáfum í Eyjafirði [Common Gull *Larus canus* in Eyjafjörður, (N-Iceland) still on the increase] (in Icelandic, English summary). Natturufraedingurinn 83(3-4):159–166.

Tomkovich, P.S., and Soloviev, M.Y. 2012. Долгосрочные изменения обилия некоторых видов птиц на севере Колючинской губы (Чукотский полуостров) [Long-term changes in abundance of some bird species in the north of Kolyuchinskaya Bay, Chukotsky Peninsula]. Bulletin of Moscow Society of Naturalists: Biological Series 117:11–20.

Tomkovich, P.S., and Sorokin, A.G. 1983. Фауна птиц Восточной Чукотки [Avifauna of eastern Chukotka]. In: Flint, V.E., and Tomkovich, P.S., eds. Distribution and taxonomy of birds: Research on fauna of the Soviet Union. Moscow: Moscow University Publications. 77–159.

Uspensky, S.M. 1984. Life in the high latitudes: A study of bird life. Russian Translation Series, 99-0498079-9; 18. Rotterdam: A.A. Balkema. 385 p.

U.S. Fish and Wildlife Service. 2009. Alaska Seabird Conservation Plan. Anchorage: U.S. Fish and Wildlife Service, Migratory Bird Management. 136 p. https://absilcc.org/science/Plans/Alaska%20Seabird%20Conservation%20Plan%20USFWS.pdf

Verreault, J., Bech, C., Letcher, R.J., Ropstad, E., Dahl, E., and Gabrielsen, G.W. 2007. Organohalogen contamination in breeding Glaucous Gulls from the Norwegian Arctic: Associations with basal metabolism and circulating thyroid hormones. Environmental Pollution 145(1):138–145. http://dx.doi.org/10.1016/j.envpol.2006.03.049

Verreault, J., Verboven, N., Gabrielsen, G.W., Letcher, R.J., and Chastel, O. 2008. Changes in prolactin in a highly organohalogen contaminated Arctic top predator seabird, the Glaucous Gull. General and Comparative Endocrinology 156(3):569–576. http://dx.doi.org/10.1016/j.ygcen.2008.02.013

Verreault, J., Gabrielsen, G.W., and Bustnes, J.O. 2010. The Svalbard Glaucous Gull as bioindicator species in the European Arctic: Insight from 35 years of contaminants research. Reviews of Environmental Contamination and Toxicology 205:77–116. http://dx.doi.org/10.1007/978-1-4419-5623-1_2

Vigfúsdóttir, F., Pálsson, S., and Ingólfsson, A. 2008. Hybridization of Glaucous Gull (*Larus hyperboreus*) and Herring Gull (*Larus argentatus*) in Iceland: Mitochondrial and microsatellite data. Philosophical Transactions of the Royal Society B: Biological Sciences 363(1505):2851–2860. http://dx.doi.org/10.1098/rstb.2008.0042

Vorkamp, K., Bester, K., and Rigét, F.F. 2012. Species-specific time trends and enantiomer fractions of hexabromocyclododecane (HBCD) in biota from East Greenland. Environmental Science & Technology 46(19):10549–10555. http://dx.doi.org/10.1021/es301564z

Wayland, M., Hoffman, D.J., Mallory, M.L., Alisauskas, R.T., and Stebbins, K.R. 2010. Evidence of weak contaminant-related oxidative stress in Glaucous Gulls (*Larus hyperboreus*) from the Canadian Arctic. Journal of Toxicology and Environmental Health, Part A 73(15):1058–1073. http://dx.doi.org/10.1080/15287394.2010.481619

Wohl, K., Wentworth, C., and Dewhurst, D. 2008. Harvest of seabirds in Alaska. In: Merkel, F., and Barry, T., eds. 2008. Seabird harvest in the Arctic. CAFF Technical Report No. 16. Akureyri, Iceland: CAFF International Secretariat, Circumpolar Seabird Group (CBird). 8–19.

Yudin, K.A., and Firsova, L.V. 2002. Паевский В.А. (Отв. ред.) Ржанкообразные Charadriiformes. Часть I. Поморники семейства Stercorariidae и чайки подсемейства [Charadriiformes. P. 1. Skuas of family Stercorariidae and gulls of subfamily Larinae]. Saint-Petersburg: Nauka. 667 p.

Zöckler, C., Kruckenberg, H., Gavrilo, M., Kondratyev, A., and Buzun, V. 2009. Status und Ökologie der Eismöwe *Larus hyperboreus* auf der russischen Insel Kolgujew in der Barentssee [Status and ecology of the Glaucous Gull *Larus hyperboreus* on the Russian Kolguev Island in the Barents Sea]. Limicola 23(1):58–78.